THE ORBITS OF ORDINARY CHONDRITES. G. K. Ustinova and V. A. Alexeev, Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, Moscow, 117334, Russia.

The orbits of 222 non-Antarctic ordinary chondrites have been estimated using the “isotopic” method. As obtained, the aphelia of ~74% of the chondrites are concentrated in the range of $\lesssim$2–2.5 AU from the Sun, and the eccentricities of ~83% of the orbits are <0.5. Only 11% of the chondrites possessed the orbits with aphelion q´ > 4 AU and eccentricity e > 0.6.

The problem of origin and evolution of meteorites cannot be resolved without the knowledge of their orbits. Meanwhile, the orbits of only four chondrites (Pribram, Lost City, Innisfree, and recently fallen Peekskill) are known exactly. However, using the so-called “isotopic” approach developed formerly [1,2], valuable information on the orbits of chondrites can be obtained due to radioactivity of Al-26. Indeed, according to the Al-26 content in the Pribram, Lost City, and Innisfree chondrites, the average gradient of ~20–30%/AU of the intensity of galactic cosmic rays over a million years exists within the area of meteorite orbits. This fact has made it possible to derive a phenomenological expression that connects the aphelion q´ with the magnitude of the Al-26 content in these chondrites. Therefore, applying this expression to the data on Al-26 content in other chondrites makes it possible now to determine the positions of their aphelia. Besides, the most probable values of semimajor axis a and eccentricity e can be estimated. When atmospheric trajectories of chondrites are known, this approach, combined with the method of apparent radiants, permits all the main orbital elements to be determined.

In this work the orbits of 102 H- and 120 L,LL-chondrites of non-Antarctic group have been estimated using the “isotopic” approach. All the available data on Al-26 content in the chondrites were drawn on, and the Al-26 saturated values were calculated in accordance with the invoked data on cosmic-ray exposure age of the chondrites [3].

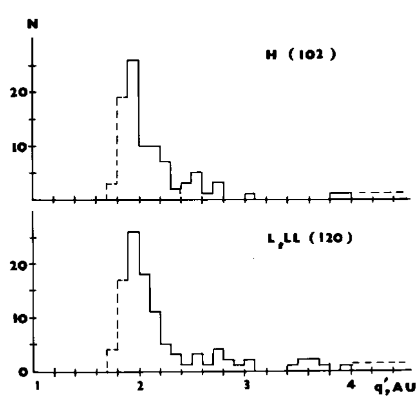

Fig. 1. Distributions of non-Antarctic ordinary chondrites over the aphelia q´ of their orbits (N is the number of chondrites per each 0.1 AU; dashed lines set off both the q´ < 1.9 AU and q´ > 4 AU uncertain regions).

The pre-atmospheric sizes of the chondrites were estimated based on the magnitudes of their recovered masses and taking into account the average ablation degree of ~85%, which follows from the track investigation [4]. Modelling Al-26 production in H- and L,LL-chondrites of different sizes due to irradiation by galactic cosmic rays with a mean modulated as well as with an unmodulated energy spectrum was fulfilled using the analytical method developed earlier [2,5]. The obtained results are presented in Figs. 1–3. The distributions of chondrites over the aphelia q´ of their orbits in Fig. 1 show that q´ of the majority of them (78% and 71% of H- and L,LL-chondrites respectively) are concentrated in the range of $\lesssim$2–2.5 AU from the Sun, both maxima (25% of H- and 22% of L,LL-chondrites) having fallen within 1.9–2 AU, i.e., near the inner boundary of the asteroid belt. The aphelia of only ~11% of ordinary chondrites lies beyond ~4 AU. Noteworthy also is the absence of chondrites at 3.1–3.4 AU, which, perhaps, corresponds to cosmic body density distribution in the asteroid belt, being conditioned by the dynamic processes in interplanetary space. Similar results had been obtained earlier [6] for smaller numbers of chondrites considered.

As shown in Fig. 2, the most probable values of eccentricity of the orbits of 86% H-chondrites and 80% L,LL-chondrites are e > 0.5, the maxima (~43–44% of the chondrites) lying in the narrow range of e ~ 0.33–0.35. The orbits of only ~11% of ordinary chondrites offer e > 0.6. It is obvious that the derived information on q´ and e of orbits of the ordinary chondrites implies that these chondrites belong to the Mars or Apollo families of asteroids. Moreover, as seen in Fig. 3, the obtained relationship between the most

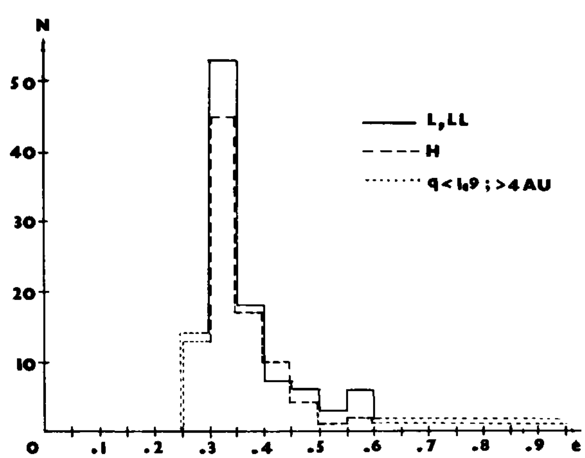

Fig. 2. Distributions of L,LL- and H-chondrites over the eccentricities of their orbits (N is the number of chondrites per each interval of e = 0.05).

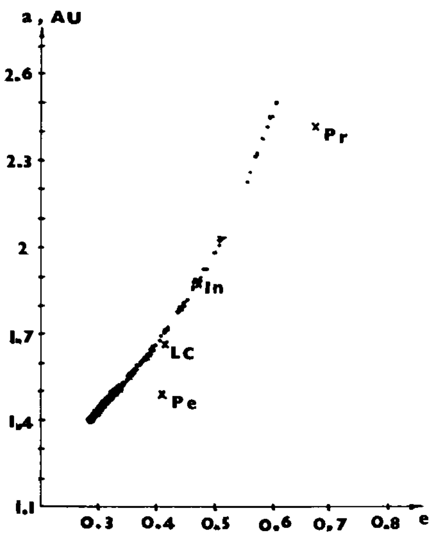

Fig. 3. a(e) regularity obtained for the most probable values of a and e of the chondrite orbits (crosses mark the values for Pribram, Lost City, Innisfree, and Peekskill).

probable values of semimajor axis a and eccentricity e of the chondrite orbits corresponds to the well-known astronomical regularity for orbits of the cosmic bodies that can fall to the Earth [7].

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